【Grant-in-Aid for Specially Promoted Research】

Science and Engineering (Mathematics/Physics)

Title of Project : Materials property and evolution of Earth's core

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Research Area : Mathematical and physical sciences
Keyword : Physical properties, Element fractionation, Mineral resources

【Purpose and Background of the Research】

We will perform high-pressure experiments on the metallic core, located at the central part of the Earth, with the aim to study its structure, origin, and evolution. The current understanding of core materials is much less than that of Earth's mantle materials, because 1) it has long been very difficult to produce ultrahigh-pressure and -temperature conditions corresponding to the core by static experiments, and 2) experiments on liquid are indeed harder than those on solids (most of the Earth's core is in a liquid state).

In this study, we will measure sound velocity, density, crystal structure, element partitioning, melting temperature, thermal conductivity, etc., based on the experiments on both liquid and solid iron and iron compounds, by using our world-leading techniques of generating ultrahigh-pressure and -temperature conditions and of measuring physical and chemical property at high pressure. These experimental results can tightly constrain the chemical composition of the Earth's core. We will also examine the core dynamics, thermal and chemical evolution of the core, and interaction between core and mantle.

【Research Methods】

High-pressure experiments will be carried out, primarily using the laser-heated diamond-anvil cell (DAC) (Fig. 1). Our group can measure material's property under extreme conditions beyond the center of the Earth (365GPa, ~6000K).

Fig.1. High-pressure device called diamond-anvil cell (DAC)

Measurements will be performed mainly at synchrotron radiation source of SPring-8. We will determine the longitudinal wave velocity of liquid iron alloy at high pressure and temperature based on the inelastic X-ray scattering measurements at the beamline BL35XU. We will also examine crystal structure and density by X-ray diffraction and X-ray absorption methods at BL10XU. Furthermore, the X-ray beams will be focused down to ~400-nm size, which helps to precisely determine the phase boundary, melting point, and *P-V-T* equation of state. We will also utilize transmission electron microscope to obtain chemical analysis of the sample recovered from DAC.

【Expected Research Achievements and Scientific Significance】

There remains much unknown about the core, in particular the liquid outer core (Fig. 2). The measurements of physical and chemical properties of iron alloys at ultrahigh pressures in this study should promote our understanding of the core extensively. The chemical composition of the core, for example, has profound implications for the scenarios of planetary formation, because it should have reflected the origin of the Earth and the core formation processes.

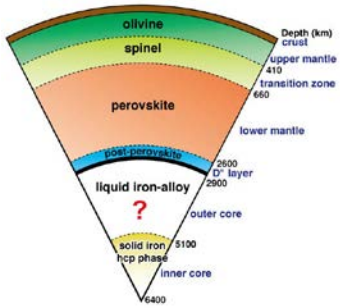

Fig.2. Stratification inside the Earth and the change in primary minerals

【Publications Relevant to the Project】

・Tateno, S., Hirose, K., Ohishi, Y., Tatsumi, Y., The structure of iron in Earth's inner core, Science, 330, 359-361 (2010).
・Ozawa, H., Takahashi, F., Hirose, K., Ohishi, Y., Hirao, N., Phase transition in FeO and stratification in Earth's outer core, Science, 334, 792-794 (2011).

【Term of Project】 FY2012-2016

【Budget Allocation】 375, 000 Thousand Yen

【Homepage Address and Other Contact Information】

http://www.geo.titech.ac.jp/lab/hirose/home.html